

SIR-C/X-SAR'S "SCIENCE-DRIVEN" GROUND SYSTEM: BENEFITS AND COST EFFICIENCIES

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Mission operations systems vary widely as a function of mission objective, reliability, target, and other parameters. When the objective is simple, the reliability requirement low, and the target cooperative, operations costs tend to be lower. All of these, and thus the runout cost of the mission, are generally driven by the manner of the relationship between the mission and its end user. The user often determines the objective, target, reliability, data products, etc., and of course it is he/she who, in the end, has to be satisfied. Scientific remote sensing missions traditionally have as their users a science team who pose a set of questions, determine or approve the instrumentation and mission that will address those questions, and often specify the nature and quantity of data to be produced. As such, it is the science team who controls and/or drives the costs of the mission, particularly the costs of the operations phase.

For nonadaptive missions who do not require many changes to prelaunch plans, an option to contain costs is to disconnect the science team from the mission operations, thus maintaining a fixed goal and, hopefully, a fixed cost. If applicable, this option also enables substantial automation of both uplink and downlink processes. Another option, and perhaps the only option for highly adaptive missions, is to tightly connect science with operations and with resource management as well. Through such links, several advantages can be had. Advantages to operations include (1) spacecraft and instruments can more efficiently carry out objectives, (2) unneeded functions can be eliminated, and (3) tasks can be better divided among the various cooperating institutions. From a larger perspective, direct participation in operations by those with the highest investment in the output makes them directly responsible for its success. Finally, by placing those charged with mission objectives also responsible for mission resource control, trades of science output against other demands for resources are made directly, and it is possible to minimize both cost and the ratio of cost to science produced.

SIR-C/X-SAR, the combination of the US Spaceborne Imaging Radar-C and the German/Italian X-band Synthetic Aperture Radar, is a three-frequency radar remote sensing system flown as a part of the Space Radar Lab on Shuttles STS-59 and STS-68 in 1994. Its ground operations system embodied the above concept by forming a team of scientists, designers, managers and engineers to participate in ground operations. The system operated three processes: pre-flight plan formulation, which allocated available resources (e. g., observation time, and geometry, power, downlink capacity) to experiments; an inflight replanning process incorporating late changes into that plan; and a parallel one-hour, process using latest orbit data to set the radars' operating parameters. This plan-within-a-plan system was robust enough to accommodate the missions' highly adaptive nature, adapting to last-minute changes in field conditions, actual achieved orbit, and Shuttle events. Because the flight operation period was short (10 days) the use of higher-level personnel was also inexpensive and efficient.

At the outset of the Project, a team of 52 investigators **formed mission science** objectives and designed **experiments to achieve them**. **Experimenters** and their **representatives** participated in field activities at the **experiment** sites, flight **system** operation, or both. Engineers and designers involved in flight hardware and software design and fabrication later joined the experimenters and Shuttle controllers in a combined simulation and training activity. The resulting team created a skill mix and dedication level that could never have been **achieved** through training alone. During operations, this team drove the experiment to an outstanding success. Mission operations cost for **SIR-C/X-SAR** was remarkably low.

In this talk, the following principles will **be** addressed as useful ways of containing costs in an adaptive mission **given** the environment which science remote sensing now operates:

1. Close] y link the science management with the crest control and operations elements.
2. Maintain tight communications between the mission planners and the science. If possible, make them the same individuals.
3. Allow and even require that operations personnel have a stake in the **outcome**.

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SRL-2 Interferometry

How close do we have to be?

